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USSR Report

GEOPHYSICS, ASTRONOMY AND SPACE

No. 453

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JPRS 74244

25 September 1979

USSR REPORT

GEOPHYSICS, ASTRONOMY AND SPACE

No. 453

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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I. ASTRONOMY

Abstracts of Scientific Articles

FLARING X-RAY PULSAR IN DORADO

Moscow PIS"MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 5, No 7, 1979
pp 307-312

[Article by Ye. P. Mazets, S. V. Golenetskiy, V. N. Il'inskiy, V. N. Panov, R. L. Aptekar', Yu. A. Gur'yan, I. A. Sokolov, Z. Ya. Sokolova and T. V. Kharitonova, Physical-Technical Institute, "Flaring X-Ray Pulsar in Dorado"]

[Abstract] Instrumentation aboard the "Venera-11" and "Venera-12" on 5 March registered a very intensive gamma burst which undoubtedly was also registered by many instruments operating at this time in space. With respect to its characteristics, this event differed sharply from all earlier observed γ-bursts. The burst was characterized by a very sharp commencement. In 50 msec the counting rate increased from the background level to $\geqslant 5 \cdot 10^5$ sec^{-1}. This means that in a short time ($\sim$0.1 sec) the flux of hard X-radiation exceeded the level of the cosmic diffuse background by a factor of 10^4. Then the intensity of the radiation decreased rapidly by more than two orders of magnitude. The subsequent stage of the burst is still more remarkable. The data show that there was radiation of an X-ray pulsar with a period 8.1$\pm$0.1 sec. The mechanism of generation of radiation is activated virtually instantaneously and the radiation attenuates rapidly. This source differs quite sharply from known transient X-ray objects, primarily with respect to the time scales of variability and the presence of a very sudden initial stage. It is improbable that the flaring X-ray pulsar FXP 0520-66 observed on this date is unique in the Galaxy. Other such objects probably exist and should be observed. However, the distances to them will be considerably greater —- several kiloparsecs and the radiation flux from them should be small and comparable with the flux from other X-ray sources. This circumstance, if one takes into account the brevity of the phenomenon, means that flaring X-ray pulsars could be observed primarily in their sudden initial stage in the form of short hard γ-ray bursts.
[484-5303]

DISTRIBUTION OF SOURCES OF COSMIC GAMMA BURSTS IN CELESTIAL SPHERE

Moscow PIS"MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 5, No 7, 1979
pp 313-316

[Article by Ye. P. Mazets, S. V. Golenetskiy, V. N. Il'inskiy, V. N. Panov, R. L. Aptekar', Yu. A. Gur'yan, I. A. Sokolov, Z. Ya. Sokolova and T. V. Kharitonova, Physical-Technical Institute, "Distribution of Sources of Cosmic Gamma Bursts in the Celestial Sphere"]

[Abstract] The number of γ-bursts registered by "Konus" apparatus aboard the "Venera-11" and "Venera-12" by late November 1978 was 35. The total duration of observations during this period was 77 days. The processing of the results of observations of such a number of events in one experiment makes it possible to obtain quite convincing demonstration of the galactic localization of the sources ot γ-bursts. One of the observational criteria of the galactic localization is the form of the dependence of the frequency of manifestation of γ-bursts on their intensity, which differs sharply from the law $S^{-1.5}$. A necessary confirmation of the galactic nature of the phenomenon is data on the distribution of sources of γ-bursts in the celestial sphere, a subject dealt with in detail in this article. In the "Konus" experiment the direction to the source of a γ-burst is evaluated by the triangulation method on the basis of the time of the relative lag in arrival of a γ-burst when the event is registered at two stations and independently at each station on the basis of the readings of a system of detectors with an anisotropic angular response. The unambiguous localization of a source within a small region by the second method is possible only with total stabilization of the spacecraft. The angular dimensions of the localization region are determined by the accuracy in measuring the intensity of the γ-burst and the stabilization accuracy and for most events constitute a few degrees. The authors were able to plot the regions of localization of 15 sources of γ- bursts on a map of the celestial sphere in galactic coordinates. The sources are not randomly distributed but are in two groups, one of which, the more compact one, occupies the galactic center. In general, in a circle with a radius of about 40° there are nine of the observed fifteen sources. It follows from the fact of concentration of the sources of bursts in the celestial sphere in the neighborhood of the galactic center and the absence of an appreciable concentration toward the disk plane that the sources of the bursts do not belong to the population of the plane subsystem of the Galaxy. The mean distances to most sources of registered γ-bursts are comparable with the distance to the center of the Galaxy -- several kiloparsecs.
[484-5303]

II. METEOROLOGY

Abstracts of Scientific Articles

ATTENUATION OF OPTICAL RADIATION BY ATMOSPHERIC AEROSOL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 2, 1979 pp 343-346

[Article by V. I. Khvorost'yanov, Ukrainian Scientific Research Hydrometeorological Institute, "Attenuation of Optical Radiation by Atmospheric Aerosol"]

[Abstract] The cross section of aerosol attenuation of atmospheric radiation σ is essentially dependent on the wavelength of radiation λ and relative humidity H. The dependence $\sigma(\lambda)$, determined by the empirical Angstrom law $\sigma(\lambda)\sim\lambda^{-Q}$, has been well studied. The dependence $\sigma(H)$ has been determined experimentally and by empirical allowance for the condensation growth of aerosol. In this paper, using the condensation models formulated by L. M. Levin, Yu. S. Sedunov and V. I. Smirnov, the author has obtained the dependences $\sigma(\lambda)$ and $\sigma(H)$. The correlation between them has been established and the parameters determining them are related to the microphysical characteristics of aerosol. It is shown that the main contribution to the attenuation of optical radiation is from particles in the range of radii 0.1-0.6μm. Under given conditions the experimental and theoretical curves are close. It is clear that atmospheric turbidity, in the case of a relative humidity greater than 70%, is caused by an increase in the size of cloud condensation nuclei measuring 0.1-1μm; although atmospheric aerosol is a complex multicomponent mixture, the dependences $\sigma(\lambda)$, $\sigma(H)$ can be described using one or two distribution functions. Variations of the refractive index for the matter in nuclei from 1.5 to 1.33 indicate that its value has but a slight effect on the σ value. With an increase in humidity the dependence of attenuation on wavelength decreases. Under certain given conditions attenuation increases with wavelength. This effect should be observed when there is high humidity in hazes containing an adequate number of large particles. When σ is measured at two wavelengths it is possible to determine the dependence $\sigma(H)$ and predict the range of visibility.
[483-5303]

III. OCEANOGRAPHY

Abstracts of Scientific Articles

ANALYTICAL SOLUTIONS FOR EKMAN TURBULENT LAYER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 1, 1979 pp 68-72

[Article by Academician G. I. Marchuk, V. P. Kochergin, V. I. Klimok and V. A. Sukhorukov, Computation Center, Siberian Department USSR Academy of Sciences, "Analytical Solutions for the Ekman Turbulent Layer of the Ocean"]

[Abstract] A study was made of analytical solutions obtained within the framework of differential models of the upper quasihomogeneous layer of the ocean. Using the equations for the Ekman turbulent layer of the ocean as a point of departure, several variants of stationary solutions are obtained. After analyzing these solutions, a similar examination is made for a nonstationary case.
[482-5303]

MINIMUM THERMAL EXPANSION OF WATER IN WORLD OCEAN

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 3, 1979 pp 720-724

[Article by D. M. Filippov, V. P. Kut'ko, S. A. Oleynikov, A. I. Pereskokov and V. N. Stasenko, "Layer of Minimum Thermal Expansion of Water in World Ocean"]

[Abstract] It is known that for the ranges of change in temperature, salinity and pressure existing in the ocean the isobaric coefficient of expansion of sea water increases with an increase in temperature, with an increase in pressure and an increase in salinity. However, until now there have been no direct measurements of the parameter nor indirect computations. Using observational data registered at hydrological stations occupied in the world ocean

during the years 1920-1970, for each station an electronic computer was used for computing the values of the isobaric expansion coefficient at standard horizons. Then, using a five-degree grid unit as a unit area, statistical processing was carried out for all stations falling into this five-degree square, for half-years and for a year. It was found that the thermal expansion of sea water has a number of peculiarities. For example, there is a water layer with minimum values of the isobaric expansion coefficient. The depth of the extremum in the northern part of the Pacific Ocean varies with latitude (from 1,800-2,000 m in the entire equatorial zone 0-20°N to 75-100 m in the Bering Sea and the Sea of Okhotsk). Figure 1 is a map of the depth (in m) of the core of the water layer with minimum values of thermal expansion (North Pacific, mean values for year). Figure 2 gives the value of the isobaric expansion coefficient in the core of the water layer with minimum values of thermal expansion (North Pacific, mean values for year). In individual seasons (in winter in the northern hemisphere) in the high northern latitudes the layer of minimum values can be wedged out toward the ocean surface. In the North Pacific the isohypses (lines of equal depths of the extremum) have a general direction from SW to NE. In the equatorial region (in the latitude zone 0-20°N) the relief of this characteristic surface is smoothed and here the depth of the extremum is 1,800-2,000 m.
[485-5303]

IV. TERRESTRIAL GEOPHYSICS

Abstracts of Scientific Articles

STRUCTURE OF OCEANIC LITHOSPHERE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, GEOLOGIYA I RAZVEDKA in Russian No 7, 1979 pp 11-28

[Article by A. M. Gorodnitskiy, Institute of Oceanology, "Structure of the Oceanic Lithosphere According to Geological-Geophysical Data"]

[Abstract] The paper gives a detailed analysis of a crystallization model of formation of the oceanic lithosphere. The model makes it possible to obtain a number of dependences which make it possible to estimate the thickness of the lithosphere on the basis of averaged data on bottom relief, on age of the bottom, on gravitational anomalies, on the results of measurements of the heat flow through the ocean floor, and also on the basis of the maximum elevation of volcanoes on the oceanic lithosphere. Comparison of computed data with experimental determinations of thickness of the lithosphere by seismological methods and electromagnetic sounding indicates a good agreement. Figure 4 in the text shows the results of determination of thickness of the lithosphere by the different methods discussed in the text. On the basis of a generalization and analysis of geomorphological and geological-geophysical data for the area of the world ocean it was possible to compute the first global map of the oceanic lithosphere, reproduced in the article as Fig. 5. By the method described in the article it was possible to construct sections and schematic maps of thickness of the lithosphere for individual regions of the Pacific Ocean using data obtained during voyages of the "Akademik Kurchatov" and "Dmitriy Mendeleyev." The comparisons of the results of computations of the thickness of the lithosphere on the basis of data obtained by individual methods and comparison of computed data with data from seismological investigations indicate the possibility of effective use of the method described in this paper for estimating the thickness of the oceanic lithosphere.
[473-5303]

ELECTROMAGNETIC SOUNDING WITH MHD GENERATOR

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 3, 1979 pp 578-582

[Article by Corresponding Member USSR Academy of Sciences G. I. Gorbunov, I. V. Bel'kov, V. I. Pavlovskiy, A. A. Zhamaletdinov, P. L. Katseblin, Yu. P. Kachayev, Academician Ye. P. Velikhov, Yu. M. Volkov, Yu. A. Dreyzin, Yu. I. Kuksa, A. V. Zotov, V. V. Yevstigneyev, A. S. Lisin, M. A. Lakhs, Academician B. P. Zhukov, V. V. Vengerskiy and Yu. P. Babakov, "Deep Electromagnetic Sounding With a Magnetohydrodynamic Generator on the Kola Peninsula"]

[Abstract] An experiment with deep electromagnetic sounding on the Kola Peninsula has been carried out since late 1976. The attained range of signal registry is 750 km. Each such generator consists of three principal units: plasma generator, MHD channel and nonferrous electromagnet. In the plasma generator there is combustion of special solid fuel with easily ionized alkali metal. In the MHD channel the supersonic flow of plasma, formed by the combustion products, is slowed under the influence of the electromagnetic field. The kinetic energy of the plasma is transformed into an electric current. An unusual characteristic of the experiment is the use of the gulfs and sea basin around the Sredniy and Rybachiy Peninsulas as a natural current circuit. Measurement of the source field was accomplished over the entire territory of the Kola Peninsula and partially in Karelia.

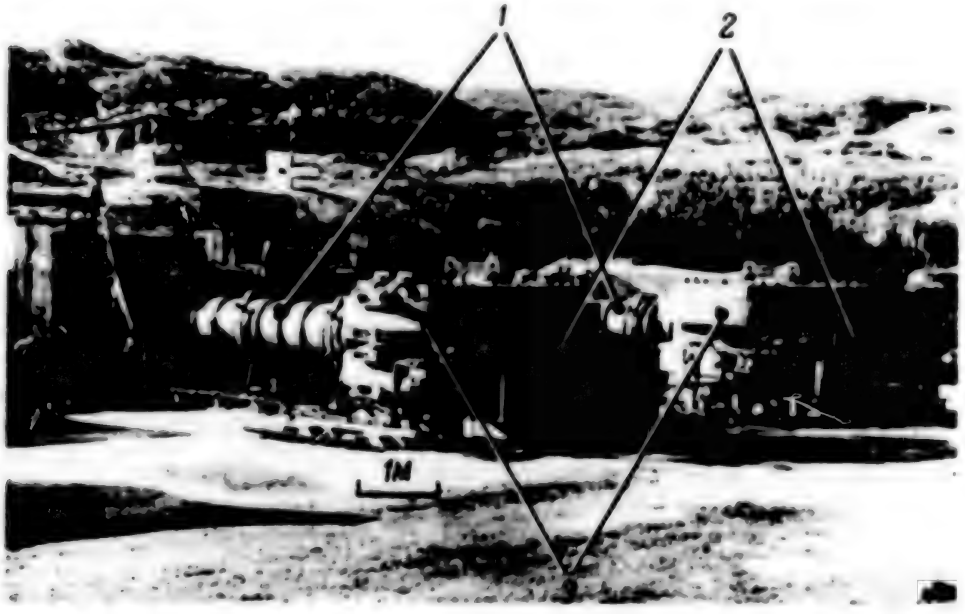


Fig. 1. MHD apparatus "Khibiny-1" on Sredniy Peninsula; 1 -- plasma generators, 2 -- MHD channels, 3 -- electromagnets

The investigated region consists of ancient crystalline rocks of Archaean and Proterozoic age. The principal objective of the experiment is clarification of the model of the earth's conductivity at depths of 20-100 km. Another problem to be solved is areal geoelectric mapping of the entire Kola Peninsula. This will make it possible to detect major conducting blocks in the earth's crust, classified as ore fields, and also to discover deep faults. It is concluded that it will be possible to use the "Khibiny" MHD apparatus in studying the internal structure of ore fields and for a joint analysis of the results with data from deep and superdeep drilling.
[485-5303]

LOCAL CHANGES IN SEISMIC VELOCITY ANALYZED

Moscow NEFTEGAZOVAYA GEOLOGIYA I GEOFIZIKA in Russian No 6, 1979 pp 31-35

[Article by S. V. Sanarov, A. F. Sokolov and L. V. Mustafina, "Geological Interpretation of Local Changes in Seismic Velocity"]

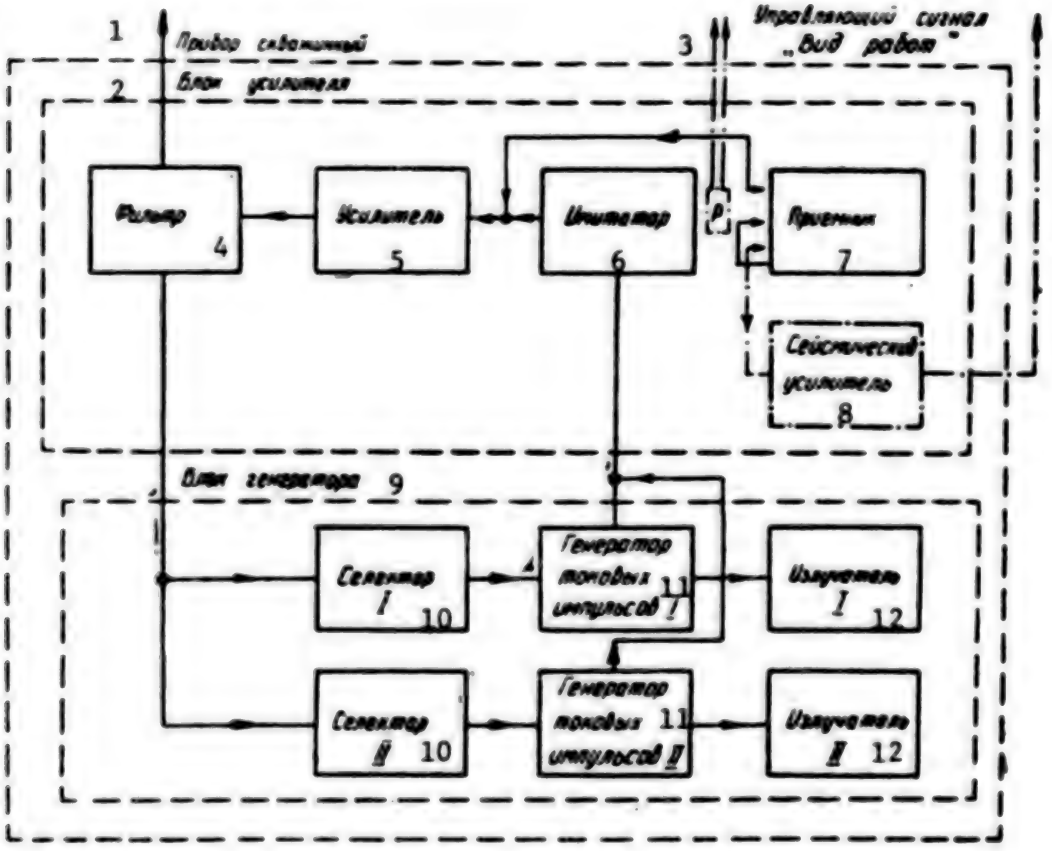
[Abstract] In this paper it is shown that on the basis of the character of change in interval velocities it is possible to judge the morphogenetic nature and petroleum and gas deposits of local structures. Over all uplifts in which petroleum deposits are detected it is possible to observe a local decrease in velocities. This is attributable to an increased fissuring of the rocks in the arch of the uplift and the possible influence of the deposit itself. Prior to the planning of detailed seismic prospecting work it is necessary to compile a prognostic map of velocities for each area to be studied and also to develop geological models of local structures which may be characteristic of a particular area. Composite maps for the principal reflecting surfaces are issued in two variants -- with constant and variable interval velocities. For precise measurements of interval velocities it is necessary to develop a network of control points situated under characteristic structural-tectonic conditions. For each morphogenetic type of local structures it is desirable to obtain standard maps of interval velocities. Regional and local velocity maps should have the same significance in geological documentation as structural-tectonic maps.
[479-5303]

SEISMOACOUSTIC LOGGING BY COMPLEX BOREHOLE INSTRUMENT

Moscow NEFTEGAZOVAYA GEOLOGIYA I GEOFIZIKA in Russian No 6, 1979 pp 35-38

[Article by L. G. Mysina, I. B. Buk, V. K. Balmashov, A. V. Smirnov, A. A. Suleymanov and I. A. Baranov, All-Union Scientific Research Institute of Nuclear Geology and Geophysics and "Kuybyshevneftegeofizika" Trust, "Seismoacoustic Logging by Complex Borehole Instrument"]

[Abstract] A complex seismoacoustic instrument has been developed which is based on the SPAK-2M standard acoustic probe, to which has been added a seismic amplifier and switch which makes it possible to carry out, alternately, acoustic and seismic logging.



KEY:

1. Borehole instrument
2. Amplifier unit
3. Controlling signal "type of work"
4. Filter
5. Amplifier
6. Simulator
7. Receiver
8. Seismic amplifier
9. Generator unit
10. Selector
11. Current pulse generator
12. Emitter

The use of complex seismoacoustic probes makes it possible in one lowering-raising operation to carry out seismic and acoustic measurements in boreholes, which is economically more advantageous than carrying out the work separately: there is a considerable reduction in the time needed for processing the borehole, the work is done by one detachment instead of two, and there is an increase in the accuracy of the measurements in boreholes when comparing data from acoustic and seismic logging. The sequence of seismoacoustic measurements with the complex probe is as follows: during lowering of the instrument into the borehole acoustic logging is carried out with internal excitation of oscillations; then the instrument is switched to external synchronization and during its raising there is registry of the acoustic noise in the borehole on a magnetic carrier in order to detect and study hydrodynamically related strata and in order to solve other problems; at individual points there is seismic logging with sources of an explosive or nonexplosive type situated on the ground surface, or interborehole sounding when the source is situated in an adjacent borehole. The described complex probe, described here in detail, is illustrated schematically in the block diagram reproduced above. An example of use of this apparatus is given.
[479-5303]

V. UPPER ATMOSPHERE AND SPACE RESEARCH

News

TASS ANNOUNCES LAUNCHING OF "COSMOS-1118"

Moscow TASS in English 1950 GMT 27 Jul 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1118" was launched in the Soviet Union on 27 July 1979. The satellite was inserted into an orbit with the following parameters:
— initial period, 89.1 minutes;
-- apogee, 273 kilometers;
-- perigee, 222 kilometers;
-- orbital inclination, 81.4 degrees.

Incoming data are being processed at the "Priroda" State Scientific Research Center.
[489-5]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1119"

Moscow TASS in English 1558 GMT 3 Aug 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1119" was launched in the Soviet Union on 3 August. The satellite was inserted into an orbit with the following parameters:
— initial period, 89.1 minutes;
— apogee, 267 kilometers;
-- perigee, 222 kilometers;
-- orbital inclination, 81.3 degrees.
[489-5]

SIBERIAN DEPARTMENT LEADS IN CLOSED ECOLOGICAL SYSTEMS

Moscow IZVESTIYA in Russian 10 Aug 79 p 3

[Article by B. Konovalov: "The Scientific Outpost on the Yenisey"]

[Editorial Report] In an interview with an IZVESTIYA correspondent, A. S. Isayev, Chairman of the Presidium of the Krasnoyarskiy Affiliate of the Siberian Department of the USSR Academy of Sciences and Corresponding Member USSR Academy of Sciences, indicated that the Department of Biophysics at Krasnoyarsk, which is presently under the Physics Institute imeni L. V. Kirenskiy, is likely to achieve independent status. According to the article, the department is already a leader in the field of closed ecological systems, which is "a fundamental problem related to the conquering of space and the creation of planetary laboratories and large-scale orbital stations."
[488-5]

SOVIET PLANS FOR MANNED AND AUTOMATIC SPACEFLIGHT

Moscow World Service in English 1000 GMT 23 Jul 79

[Editorial Report] Moscow's "World Service," in its "Moscow Mailbag" program, answered an Indian listener's question about Soviet space research: "According to Academician Sagdeyev, Director of the Institute of Space Research, we will continue exploration of the planets of the solar system by automatic vehicles, such as moon rovers on the moon or automatic probes soft landing on Mars and Venus. As for manned missions, they will concentrate on research to find out how long cosmonauts could live and work in space without harm to their health. "The high-road of our manned space research is the creation of permanent orbital stations, skylabs with interchangeable crews. These will be large skylabs with crews of 10 to 20 people. These labs will be in orbit for periods as long as 10 years. The initial stage of this program is already under way." One of the aims of relatively long flights was a study of the influence of zero gravity on the human organism. "And the time for a Mars mission will no doubt come."
[487-5]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1120"

Moscow TASS in English 1329 GMT 11 Aug 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1120" was launched in the Soviet Union on 11 August 1979. The satellite was inserted into an orbit with the following parameters:
-- initial period, 89.8 minutes;
-- apogee, 376 kilometers;
-- perigee, 181 kilometers;
-- orbital inclination, 70.4 degrees.
[489-5]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1121"

Moscow PRAVDA in Russian 16 Aug 79 p 3

[TASS Report: "Cosmos-1121"]

[Abstract] The artificial earth satellite "Cosmos-1121" was launched in the Soviet Union on 14 August 1979. The satellite was inserted into an orbit with the following parameters:
-- initial period, 89.7 minutes;
-- apogee, 375 kilometers;
-- perigee, 180 kilometers;
-- orbital inclination, 67.2 degrees.
[489-5]

TASS ANNOUNCES LAUNCHING OF "MOLNIYA-1" COMMUNICATIONS SATELLITE

Moscow TASS in English 1200 GMT 31 Jul 79

[Abstract] On 31 July 1979 the Soviet Union launched a "Molniya-1" communications satellite as part of the system for long-range telephone and telegraph communication and transmission of USSR Central Television to remote areas of the country. The satellite was inserted into a high elliptical orbit with the following parameters:
-- period, 12 hours 17 minutes;
-- apogee, 40,860 kilometers in the northern hemisphere;
-- perigee, 470 kilometers in the southern hemisphere;
-- inclination, 62.8 degrees.
[489-5]

GERMAN PRESS HINTS AT SOVIET SPACE STATION FOR 12-14 PERSONS

Frankfurt FRANKFURTER ALLGEMEINE in German 21 Aug 79 pp 7, 8

[Unsigned article]

[Excerpt] Even though the results of medical investigations [of the two recently returned cosmonauts Valeriy Ryumin and Vladimir Lyakhov] are not yet in, it can already be said with a certain amount of assurance that man was able to withstand a half year in outer space without suffering major damage. Now, on the basis of previous Soviet announcements, it can be expected that flights of up to one year in duration can be undertaken. However, the Soviets cannot begin these operations for several months yet, that is to say, until all medical data have been fully evaluated and the convalescence of the cosmonauts has been observed very carefully.

Future progress has long been planned by the Soviets. In the next decade, according to cosmonaut Vitaliy Sevast'yanov, new types of large space stations, which are now under development, are to be launched. They will accomodate 12-14 persons. These stations will have to be assembled in space from individual modules launched into orbit from earth. Toward this purpose, assembly personnel will have to remain in space for longer periods of time. Thus, it is evident that the recent Soviet experience is already very important with respect to these space assembly operations.

As for the 1990's, at least insofar as reported by the Soviet NOVOSTI news agency some time ago, still more ambitious plans exist. Space stations which can accomodate up to 120 persons on board are being contemplated. The way toward a permanently manned station is thus already indicated. Such stations will certainly not be used solely for peaceful purposes but will surely be used for military reconnaissance -- quite apart from uses involving the potential development of laser and other beam weapons. [492-5]

PARIS PRESS REPORTS FLIGHT OF FRENCH COSMONAUT WILL PRECEDE VENUS MISSION

Paris LE MONDE in French 6 Sep 79 p 14

[Unsigned article: "A French Cosmonaut Could Fly on Board a 'Soyuz' by 1982"]

[Text] The French cosmonaut who would become part of a "Soyuz" crew and spend several days on the "Salyut" station could fly by 1982. This is according to Hubert Curien, President of the Centre National d'Etudes Spatiales (CNES). The 1982 target date is the first indication of the time required in defining mission objectives, selecting candidates and teaching them Russian; another 12-18 months for training at Star City near Moscow is foreseen. This date must also be compatible with the Soviet space program. But the

flight of this cosmonaut will take place before the other important French-Soviet project, the flight of a balloon into the Venusian atmosphere. This operation had been envisaged for 1983, but technical difficulties greater than had been expected have caused delays.

It was during the French-Soviet summit in April 1978 that President Brezhnev proposed to the President of France the participation of Frenchmen in the Soviet manned program, a proposal that was immediately accepted in principle. A French delegation comprised of doctors and space technologists will leave for Moscow in order to establish with the Soviets the required physical criteria and the method of cosmonaut selection.
[1853/8-5]

COMMENTARY ON SPACE RADIOTELESCOPE

Moscow IZVESTIYA in Russian 27 Jul 79 p 3

[Article by B. Konovalov: "Radio Telescope in Orbit"]

[Text] Vladimir Lyakhov and Valeriy Ryumin marked their singular anniversary -- five months of presence in orbit -- by the beginning of experiments with the "KRT-10" radiotelescope. These are experiments which are opening a new stage in the development of exoatmospheric astronomy; indeed, for the first time in the history of human civilization a radiotelescope has begun to operate in a space orbit.

The radiotelescope arrived in the freighter in unassembled form. The cosmonauts, after they had unloaded the "Progress-7" and had loaded it with no longer needed equipment, proceeded to the assembly of the radiotelescope. The control panels, recording apparatus and precise time system were placed within the station's working compartment. The cosmonauts installed apparatus for the attachment, extension and separation of the antenna in the forward chamber of the "Salyut." A folding antenna was attached to it and an instrument container was connected to its end. The antenna, similar to an umbrella, must be opened in space. Its "lobes" are connected by three supports to the instrument container, situated in the antenna focus. A parabolic dish with a diameter of 10 meters is made of a fine metallic grid. The radio waves from the universe, being reflected from the sky, enter the exciter of the focal container and from there the signal must pass along a cable inside the station, to the conversion and recording apparatus, and then to the earth. Many years of work by many institutes of the USSR Academy of Sciences and industrial enterprises of our country are responsible for this apparatus, assembled by the cosmonauts.

Some of the telescope, assembled in cylindrical form, was situated in the transition compartment, whereas the other part was in the "Progress." Accordingly, the spring push rods must very precisely and gently push away

the "Progress" so that it will not damage the radiotelescope. This could be done successfully. The movement away from the ship went off very successfully.

The radiotelescope, which is no longer endangered by the "Progress," is extended forward by a special mechanism. Then the locks are opened and the umbrella of the antenna is spread open in orbit.

"Boys, we are now observing the antenna," says Lyakhov joyfully at this moment.

"We can see the antenna as an aureole around the station. We congratulate you," responds the earth.

"Express appreciation to the scientists and designers," asks Ryumin.

Now after detailed checking of the radioelectronic channel the cosmonauts proceeded to geophysical and radioastronomical investigations. The orbital antenna will operate in conjunction with an enormous surface 70-meter antenna dish situated near Yevpatoriya. Thus, a telescope with an enormous variable base will be created. This pair is equivalent to one antenna equal in diameter to the earth.

Radioastronomy, despite its youth (it is about forty years from its birth) has succeeded in occupying a solid position in investigation of the universe. According to rough estimates, approximately half the experimental data in this field of science now come specifically from radioastronomy. Remarkable quasars, having the size of stars, but having a luminosity greater than for entire galaxies; pulsars -- mysterious neutron stars; relict radioemission, generated billions of years ago -- such is far from a complete list of the sensational discoveries which science owes to radioastronomy. To a great extent precisely due to these discoveries a real revolution in the study of the universe is transpiring before our very eyes.

It is noteworthy that in Great Britain, known for its conservative traditions, the post of Royal Astronomer is now occupied by a radioastronomer. Several years ago for the first time the Nobel Prize was awarded to two radioastronomers -- Ryle and Hewish -- although, under the terms of Nobel's will, the award was to be given only for sciences of specific use to mankind and astronomy was not included.

The victorious parade of radioastronomy is in essence the annals of improvement of radiotelescopes. Now, in competition with its elder sister, having a history of a thousand years, optical astronomy, radioastronomy has reliably occupied a leading position with respect to the quality of observation instruments. Now the sensitivity of radio telescopes, the capacity for detecting weak radiation by means of quantum amplifiers, is hundreds and thousands of times greater than for optical telescopes. And this means that they can glance for greater distances into the depths of the universe and collect more information. The capacity for differentiating close spectral lines, in

other words, "natural radio stations," emitting at close wavelengths, is greater for radiotelescopes than for the best optical spectrographs.

For a long time the "Achilles heel" of radioastronomy was spatial or angular resolution, that is, the ability to differentiate two emitting objects situated one next to the other or investigate the structure of some radio source. This capability is dependent on the ratio of the length of the received wave to the diameter of the instrument. Since the length of radio waves is hundreds of thousands of times greater than for visible light, the resolution of radiotelescopes is accordingly far lower. Already in the early 1950's the radio world seemed really out of focus, nebular. It was possible to increase the "keenness" of the instruments by only one method: by increasing the diameter of the receiving antennas. But this was very complex and expensive. Indeed, the cost of an instrument increases, on the average, proportional to the cube of its size. It is very complex to make a parabolic dish with a diameter of more than a hundred meters. Therefore, radioastronomy could not gain in this way in the competition with optical astronomy.

The situation changed first of all due to use of the radiointerference method. The essence of the method is as follows: two receiving antennas are connected by a cable and simultaneous observations of radio sources are made. In this case the linear base, determining the spatial resolution, becomes the distance between the antennas. During the 1950's-1960's specialists created radiointerferometers with a distance between the antennas of several kilometers. This was an enormous leap forward. As a result it was possible, for example, to discover radio galaxies and identify them with definite optical objects.

The next step was taken by the Soviet scientists Matveyenko, Kardashev and Shelomitskiy, who work at the Space Research Institute USSR Academy of Sciences. They advanced a simple and significant idea — doing away with the cable connecting the antennas. If use is made of modern wide-band magnetic recorders and a precise time and distance service it is possible to synchronize the reception marks of the corresponding radio pulses and then, using electronic computers, feed out information of interest to researchers. Now there are many pairs of antennas operating in a matched regime over intercontinental distances, for example, Australia-United States, Crimea-California, Australia-Crimea. As a result, the spatial resolution of such instruments in the centimeter range of radio waves is thousandths of a second of arc. This is a thousand times greater than for the best optical telescopes.

Now the possibilities of this method have virtually attained their natural limit — the size of the earth. Soviet scientists proposed that a revolutionary step be taken, that one of the antennas be put into space. Now has come the golden age of radioastronomy. When the "Progress-7" moved away from the orbital station and the ten-meter antenna of the radiotelescope was opened, a new stage in the development of radioastronomy also opened.

This experiment is only the "first page," the beginning of a route on which there are no fundamental limitations. Now the antenna is situated in circumterrestrial orbit, at an altitude of 400 km. But in the future it can be placed in a geostationary orbit -- at a distance of 36,000 kilometers or 10 times more distant -- into a circumlunar orbit. Later it is possible to master a circum-Venusian or circum-Martian orbit. On the other hand, the weightlessness of space is making possible a virtually unlimited increase in the size of the antennas. Light "honeycomb" constructions, which can be put into space in parts, will make it possible to create antennas with a width of some kilometers!

"The horizons which the outstanding experiment in space are now opening up are truly grandiose," says one of the best-known radioastronomers on our planet, Corresponding Member USSR Academy of Sciences I. Shklovskiy. A real possibility may be the creation of radiointerferometers spaced at a distance of about an astronomical unit -- from the earth to the sun. Such instruments will afford fantastic possibilities for researchers. Now, for example, precise direct methods are used to determine the distances to objects only 200-300 light years from us. Beyond that distance all distances to celestial bodies are determined only by indirect methods. And how precise they are can be judged from the confusion which occurred at the beginning of the 1950's when it became clear that all distances to extragalactic objects were understated by a factor of 10! Space radiointerferometers will make it possible to make a precise determination of the distance to any remote object in the universe.

Fantastic possibilities are opening up due to the use of space holography. We will not have a two-dimensional image of objects, as is the case now, but a three-dimensional, volumetric picture. Cybernetic techniques will make it possible to do this and for example, see objects from the "back side," including Crab nebula. We will be able to investigate the structure of quasars, pulsars, and make a detailed study of interstellar nebulae, where the process of formation of stars and galactic nuclei is in progress.

...We note that this is a direction in which scientists even now are expecting major results. And as the history of science shows, the most impressive discoveries are those which are unpredictable.
[493-5303]

Translations

"SALYUT-6" PROPULSION SYSTEM OUTLINED IN DETAIL

Moscow NAUKA I ZHIZN' in Russian No 7, 1979 pp 27-33

[Article by Engineer N. Novikov]

[Text] During the time of television reports from orbit the cosmonauts have many times shown us how a fluid, such as water, poured from a vessel, floats in the spaceship cabin, gradually assuming the configuration of a sphere. If such a sphere is destroyed, each of its parts after a few instants, like a small hedgehog, is transformed into a little ball, into a spherule of lesser size. However, contact of individual liquid spheres leads to their fusion into a general mass. All this represents the operation of surface tension forces in a fluid — in a state of weightlessness they become the principal factor determining the behavior of a fluid. In the future precisely these forces will be used for carrying out the in-orbit production of solid and hollow spheres of an ideal profile and purity, which, in the opinion of specialists will constitute a real revolution in technology.

But whereas for the technologist working in the field of space production the behavior of a fluid under weightlessness conditions is an invaluable asset, for the designer of space equipment it means a lot of trouble. The most serious attention was devoted to the problems of the behavior of a fluid in space long before the creation of the first space vehicles with liquid-fuel engines. Containers with different fluids were launched on vertical rockets. In the segment of subsequent free falling different measurements were made in these containers and information on events in a container with a "weightless" fluid was transmitted along radiotelemetric lines to the earth. In addition, towers were built from which specialists dropped containers with fuel components checked by a great many sensors. It was necessary to obtain an answer to a great many specific questions and in particular, to the following: how will the fuel behave in a partially evacuated tank in a spaceship, that is, where there is a gas as well as a liquid phase?

Let's try to think this through.

First, it is entirely clear that there is no distinct discontinuity between a liquid and a gas in a state of weightlessness. Second, much will be dependent on whether the liquid wets the walls of the container or whether it

rolls from them, like water off a duck's back. As an example we will take the case of water. It beautifully wets fabric, wood, metal and paper, but it does not wet paraffin, smoked or fatty surfaces. In exactly the same way, fuel components, such as oxidizer, may either wet or not wet the internal walls of the tank. It is obvious that in the first case the fuel component is somehow distributed over the walls of the tank, but within the fluid there will be gas cavities, bubbles. In the second case, on the other hand, individual blobs of fluid will float through the entire volume of the tank in the gas medium; these blobs assume a more or less regular spherical configuration.

Which of these two cases can be given preference in the planning of the fuel system of a spacecraft?

The answer is clear: neither one nor the other. The first variant (wettable wall) is not suitable because the entry of a gas bubble into the fuel line leads to a marked increase in the hydraulic resistance of this line, and accordingly, an unintended fuel feeding regime. Arriving in the combustion chamber, the gas bubble changes the fuel combustion regime or completely shuts down the engine, whose operating regime is carefully computed and must be realized, as is well known, with the highest accuracy. And the second variant (unwettable wall) is also unsuitable -- it is unclear how the fuel in general can be fed into the combustion chamber if its components roll around within the fuel tanks. To be sure, prior to the firing of the engine it is possible to create aboard the vehicle a small artificial gravity, firing, for example, gas microengines, and thus, seemingly, forcing the fluid toward the fuel intakes. But such a method complicates the system for the control of the vehicle and reduces its reliability.

The solution for the situation which arises suggests itself: it is necessary to prevent the mixing of the liquid and gas phases in the fuel tank and still better -- completely isolate them from one another. Proceeding specifically from this general idea, the designers found specific solutions which as time has passed have become classic. Here is the simplest of them. The fuel tank, of a spherical configuration, is partitioned in half by an elastic membrane. One of the cavities so formed is for fluid and the other is for gas. During the fueling of the spacecraft on the earth, due to the excess pressure of the fluid the membrane is pressed toward the opposite wall of the container and the fluid (fuel component) thus fills the entire tank space. If some gas is now fed into the gas cavity of the tank from the outside under high pressure, acting on the membrane, like on a piston, the gas begins to drive the fuel into the engine until there is a total evacuation of the tank. Simply and neatly.

But experience has shown that only one effective construction is not enough for completely reliable functioning. The fact is that the fuel component, like any other fluid, always contains some quantity of dissolved gas. And there will be more dissolved gas the greater the gas pressure in the container in which the component is stored. In the segments of the fuel line with reduced pressure the dissolved gas, in complete correspondence with physical laws can be separated from the fluid and the very same bubbles can be formed which had just been carefully avoided.

Foreseeing such possibilities, the designers of fueling apparatus endeavored to reduce the concentration of gases in the fuel components while still on earth, even before filling of the space vehicle tanks.

The simplest method for eliminating from a fluid the gases which are dissolved in it is the reduction of the space over the fluid to a vacuum. In such a way, for example, it is possible to process water prior to the filling of the heating system of a residence so that the internal walls of the lines will subsequently be less subject to corrosion. However, "vacuuming" is inapplicable for rocket fuel components. Virtually all these components are complex fluids and vacuuming leads to an intensive evaporation of the most volatile fractions from them, and accordingly, a change in the composition and chemical properties of the component as a whole. One of the suitable methods for contending with the appearance of gas bubbles is the replacement of gases easily soluble in a fluid, such as oxygen and nitrogen, in particular, by a less soluble gas, such as helium. Such a procedure is known as deaeration, that is, the elimination of the principal air components, oxygen and nitrogen, from the fluid with their simultaneous replacement by some other gas which is not readily soluble in the particular fluid.

There are many methods for the deaeration of fluids. For example, on the bottom of a special container, a deaerator, it is possible to place a gas collector and through this introduce helium into the fluid. Passing through the fluid layer, the helium bubbles will be partially dissolved in it and at the same time there is saturation by the air released from the fluid. The air-helium mixture accumulating in the gas space is eliminated from the deaerator.

The reason for the unplanned entry of gas into the fuel tank of a space vehicle may also be the air which is situated in the fuel lines connecting the ground fueling apparatus and the ship's tanks. In order for this not to happen, all the fueling lines, as well as the tanks themselves, are carefully vacuumed prior to fueling.

It is already clear, evidently, what careful attention the designers devote to the protection of the engine part of spacecraft against gas inclusions and what serious consequences can come from the mixing of the liquid and gas phases in the engine fuel system.

An extremely complex situation once arose in this sense aboard the orbital station "Salyut-6." And although it could not be called critical in the full sense of the word, this situation required from specialists the mobilization of all their knowledge and inventiveness. And the brilliant elimination of all existing shortcomings can without hesitation be called a shining example of engineering art.

We recall that in addition to other innovations making it possible to consider the "Salyut-6" a second-generation orbital station, it carries a combined engine (CE). What is a CE?

It is known that each spacecraft, carrying out a planned flight program, makes different maneuvers in orbit. This change in the flight trajectory is a correction to the vehicle's orbit, that is, a movement of the center of mass. This is also spatial orientation when choosing the different objects to be observed, that is, its rotation about the center of mass. Finally, this is required for stabilizing the vehicle in a stipulated position over the course of a time interval necessary for observations. In order to carry out all these maneuvers there is usually a whole series of large and small engines.

Each group of engines — for correction, orientation and stabilization -- operates on its fuel components, that is, changes the fuel system independently of the others. Such a multicomponent fuel system, using different fuel vapors (fuel plus oxidizer), and also unitary (single-component) fuels and compressed gas to a certain degree complicate the spacecraft, as well as the technology of its servicing in space and on the earth. Thus, for example, it would be necessary to have all possible kinds of large and small tanks and different kinds of lines on the freighter "Progress" in order to ensure operation of the "Salyut-6" orbital station and there is need for a great many assemblies at the cosmodrome launch pad when the station is being prepared for launching. In addition, in the course of prolonged operation of a spacecraft with autonomous engines there is always a threat of out-of-proportion expenditure of the fuel in individual systems. For example, due to the absence of fuel in the orientation system a completely properly functioning vehicle cannot make a planned correction, although the correcting engine has the necessary quantity of fuel for this purpose.

The creators of the "Salyut-6" combined the fuel systems of functionally different engine groups into one. Hence its name -- combined engine, or abbreviated -- CE. It includes two correction engines, each with a thrust of 300 kilograms, and about 30 small mooring and orientation engines, each with a thrust of 14 kilograms. All the engines make use of one and the same pair of fuel components: asymmetric dimethylhydrazine (fuel) and nitrogen tetraxide (oxidizer).

The "Salyut-6" has three cylindrical tanks with fuel and an equal number of tanks with oxidizer. All six tanks are similar in design. A separating sylphon -- an elastic element resembling the folds of an accordion -- is securely attached to one of the covers of each of them. In the inner cavity of the sylphon is the fuel component — fuel or oxidizer. In another cavity of the tank, that is, over the sylphon, gaseous nitrogen is fed from high-pressure cylinders through a reducer which reduces the pressure from approximately 200 to 20 atmospheres. Creating a pressure on the sylphon, the nitrogen tends to force the fuel component into the line leading to the engine. And since asymmetric dimethylhydrazine and nitrogen tetraxide form a self-igniting fuel vapor, for firing the engine it is only necessary to open the necessary valves on the fuel lines.

During refueling of the station in orbit the nitrogen pressure in the gas cavity of the fuel tank will prevent the filling of the sylphon with the fuel component. Therefore, prior to refueling the nitrogen is eliminated

from the tanks. However, it is not discharged outside the station but is returned to the high-pressure cylinders. The pumping of nitrogen is accomplished by means of a compressor which is rather powerful by space standards — 1 KW. Such a significant power cannot be used in a continuous regime (in particular, because the solar cells also receive energy with interuptions), and the nitrogen pumping operation extends out over several days. Or, to be more precise, several work shifts.

And now we get to the essence of the complications arising aboard the "Salyut-6." At the end of work by the second main expedition, consisting of V. Kovalenok and A. Ivanchenkov, they noted deviations of the parameters for the nitrogen system for scavenging the CE fuel tanks. As before, the "Salyut" engine beautifully performed its tasks, but the behavior of the scavenging system could not but put the specialists on their toes.

A thorough analysis of CE behavior in its different operating regimes revealed that in one of the fuel tanks there was an impairment of tightness of the separating sylphon. And this means that the liquid fuel and the gaseous nitrogen propelling it were mixed in this tank. Specialists were faced with a whole series of problems. First, the damaged sylphon could not be used for the delivery of fuel to the engines: nitrogen would simply penetrate through the hole forming in the inner cavity, the necessary pressure would not be created on the sylphon and to all intents and purposes the fuel would not be expelled from the particular tank into the line. Second, the entry of gas inclusions into the engine system could result in considerable unpleasantness, which we have already mentioned before. Third, the penetration of an aggressive medium or its vapors into the gas part of the fuel system could result in damage to the entire scavenging system. And this is because the elements of this system, the cutoff and safety valves, reducers, compressor and others are intended for use in a neutral nitrogen medium, not in a medium of aggressive vapors of asymmetric dimethylhydrazine. Due to this alone the CE can completely malfunction and the flight would have to cease. Finally, fourth, there is the economic side of the matter: having been transformed into an emulsion, more than 200 kilograms of fuel already put into orbit became unsuitable for use. It had to be saved.

As you can see, there were plenty of problems to be solved.

During the many months of unmanned flight of the "Salyut-6" the creators of the engine system developed a plan of measures for preventing dangerous complications of the developing situation and for eliminating it. Modeling of the state of the CE was carried out. Special ground stands were used for testing elements of the impending operations, there was prediction and insofar as possible, checking of the behavior of the fuel system during its repair under weightlessness conditions. The final objective of all the developed measures was as follows: first free the fuel in emergency tank No 3 from the already existing gas inclusions, pump the purified fuel into the properly operating tanks of the station, and finally, cut off the tank with

the damaged sylphon from the general engine system circuit. The branching system of CE lines with the corresponding pressure-distribution fittings makes it possible not only to use any of the three tanks or pump the fuel from one tank to another, but also cut off any of the tanks from participation in further work.

On 14 March 1979 the next freighter, the "Progress-5," was docked to the "Salyut-6," aboard which Vladimir Lyakhov and Valeriy Ryumin had already worked for three weeks. In addition to numerous items of freight for further work on the station, the "Progress-5" delivered 170 kilograms of oxidizer in the tanks intended for the oxidizer and zero kilograms of fuel in the tanks intended for it. In other words, aboard the "Progress-5" the tanks for the delivery of fuel were empty. These empty tanks aboard the "Progress," as we will see below, were necessary for the impending work with the combined engine.

It was decided to delegate the work with the CE directly to the crew, although there was a possibility of controlling all the assemblies and instruments from the earth through the command radio link and delegate this work to the most skilled specialists in the field of engines. There were weighty reasons for the entire work complex being entrusted to the crew. Despite the enormous velocity of propagation of radio waves, several seconds could elapse from implementation of the command aboard the station to the appearance of a "picture" with the results on the ground operator's panel. They are expended on the reception of information from space, its processing with an electronic computer, during which the computer can repeatedly refer to other sources of information, with conversion and representation of the information in a form convenient for perception. And taking into account the speed and great seriousness of the CE operations, it is best that the Control Center specialists serve in the role of advisors and consultants to the crew. Moreover, work with the CE constitutes no danger for the crew: all the CE elements, including the lines, are situated outside the pressurized station compartments.

In preparing for the flight, V. Lyakhov and V. Ryumin rehearsed their actions on special stands and a CE model and learned to cope with the necessary technical documentation. And now on the morning of 16 March they were at the control panel for the CE systems in the working compartment of the "Salyut-6." From there by simply pressing on buttons they could open or close any of the valves and the "living" pneumohydraulic circuits of the "Salyut" and "Progress" fuel system situated here by means of corresponding signaling made it possible to see the system as a whole.

In order to guarantee the safety of the properly functioning tanks from the possible entry of gaseous nitrogen into them, it was decided to pump the fuel from the malfunctioning tank No 3 into tank No 2, which first had been freed of fluid. Using the compressor apparatus the nitrogen was eliminated from the gas cavity of tank No 1 and thus there was assurance of the possibility of refueling tank No 1 with pure fuel from tank No 2. By carrying out the necessary supercharging in tank No 2, V. Lyakhov and V. Ryumin conveyed the fuel from tank No 2 into tank No 1 until the latter was filled.

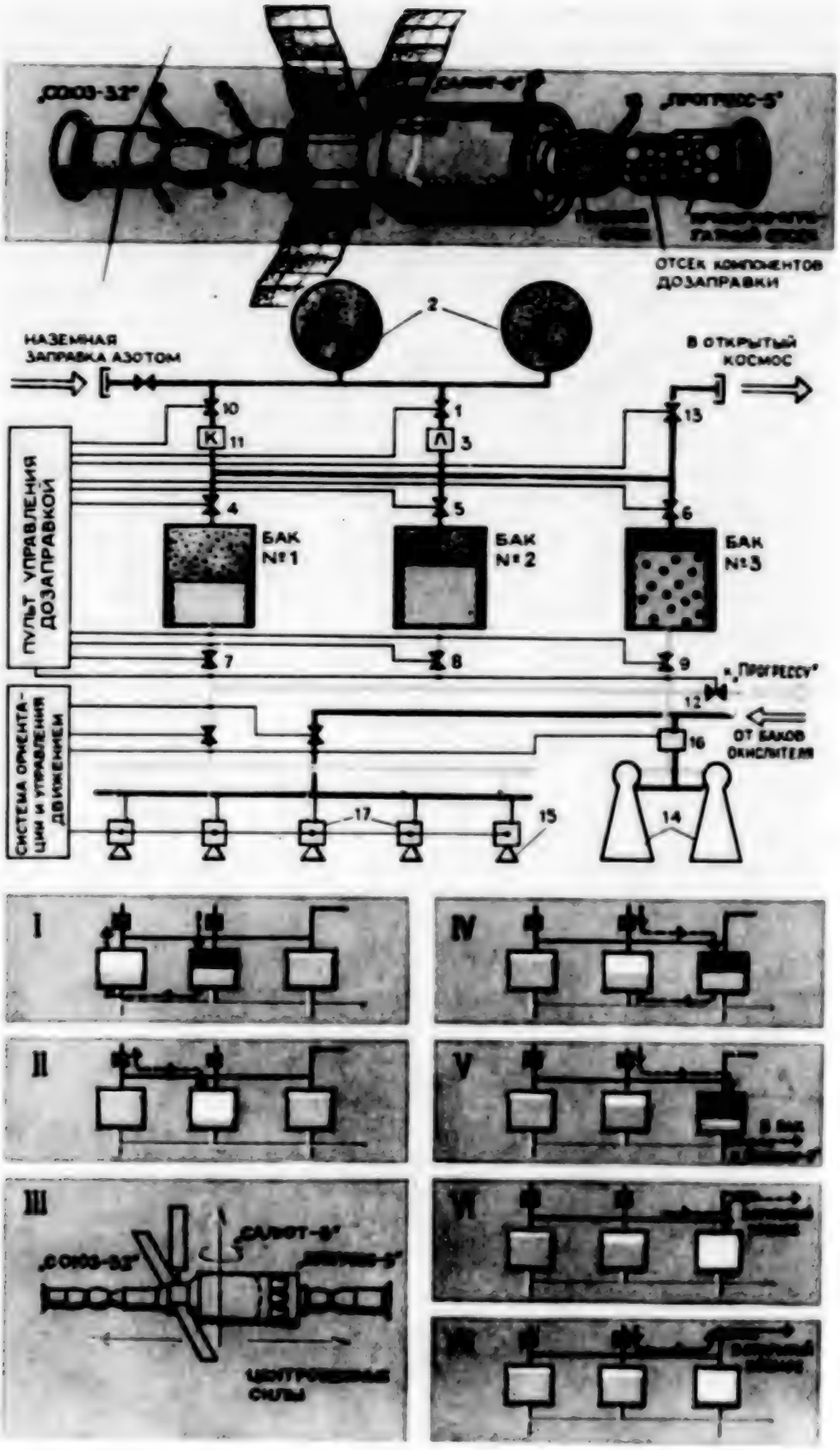
Then it remained to evacuate the nitrogen from the gas cavity of tank No 2 and it was ready for the reception of fuel from tank No 3.

The longitudinal axes of the CE fuel tanks aboard the "Salyut-6" coincide with the longitudinal axis of the station. Precisely this circumstance considerably facilitated the task of separating the gas and liquid phases in the malfunctioning fuel tank. After orienting the "Soyuz-32"-"Salyut-6"-"Progress-5" complex with the panels of solar cells of the station on the sun, V. Lyakhov and V. Ryumin turned the complex about the transverse axis with a velocity of 3° per second, that is, one revolution in two minutes. The centrifugal forces arising as a result of rotation pressed the heavy fuel in tank No 3 toward the intake pipe and the light gas inclusions present in the fluid began to "float" in the direction of the axis of rotation -- the "separator" began to operate. Aboard the "Salyut-6" the very same thing happened as in any ground separator used for separating any mixture by centrifugal forces or in a settling tank employing the forces of terrestrial gravitation and the difference in the specific gravity of the separable components.

Now specialists on earth could be sure that the feeding of nitrogen into tank No 3 for the driving of the fuel from it does not lead to the entry of this gas into the fuel line and accordingly into tank No 2.

For checking the so-called continuity of the pumpable fluid, that is, the absence of gas inclusions in it, it is sufficient to have a simple pressure sensor mounted in the fuel line. With the entry of a gas bubble into the line there is an increase in its hydraulic resistance, and accordingly, the pressure in it, to which the sensor immediately reacts. But such post-factum checking does not make it possible to safeguard the line against the penetration of gas into it. In order to guarantee the success of the experiment it was decided to pump not all the fuel from tank No 3, but only the greater part of it, something like 150 kilograms. The remaining contents of tank No 3, that is, the fuel, as they say, with unguaranteed purity, could be simply expelled into open space. However, the high aggressiveness of the asymmetric dimethylhydrazine, which would move together with the station in orbit, could lead to damage of the external elements of the station. In particular, there could be damage to the thermal insulation, antenna, external television cameras, there could be damage to the optical properties of the windows, etc. But right here the empty fuel tanks of the "Progress-5" came in handy; the remnants of fluid from tank No 3 were pumped right into them.

The first, and possibly the main part of "Operation CE" ended with this. But another, not less important part remained: freeing the nitrogen lines of the expulsion system and the cavity of the now empty tank No 3 from the remnants of the fuel and its vapors. The crew of the "Salyut-6" opened the necessary valves and the vapor-gas mixture burst into open space. A sharp decrease in pressure from approximately 20 atmospheres to a cosmic vacuum led to a decrease in the temperature of the mixture expelled from the ship. The fuel vapors instantaneously condensed and froze, forming rust-colored snowflakes, about which the cosmonauts reported to earth with delight.


„Союз-37"
„Салют-6"
„Прогресс-5"
ОТСЕК КОМПОНЕНТОВ ДОЗАПРАВКИ
НАЗЕМНАЯ ЗАПРАВКА АЗОТОМ
В ОТКРЫТЫЙ КОСМОС
ПУЛЬТ УПРАВЛЕНИЯ ДОЗАПРАВКОЙ
БАК №1
БАК №2
БАК №3
„ПРОГРЕССУ"
ОТ БАКОВ ОКИСЛИТЕЛЯ
СИСТЕМА ОРИЕНТАЦИИ И УПРАВЛЕНИЯ ДВИЖЕНИЯМИ
I
II
III
IV
V
VI
VII
„Салют-6"
„Союз-37"
„Прогресс-5"
ЦЕНТРОБЕЖНЫЕ СИЛЫ

SIMPLIFIED BLOCK DIAGRAM OF TANKS FOR FUEL ON "SALYUT-6" STATION

A. Fuel Delivery During Engine Operation

With opened valves 1 and 4 (5, 6) the compressed nitrogen from the high-pressure cylinder 2 enters through the reducer 3 into the gas cavity of tank No 1 (No 2, No 3) and creates pressure on the sylphon with the liquid component within. By opening the valve 7 (8, 9) the fuel component (fuel) is fed to the engine groups 14 and 15. The system for orientation and control of motion is responsible for control of engine operation by means of the admission valves 16 and 17.

B. Refueling

With the opened valves 4 (5, 6) and 10 the compressor 11 pumps nitrogen from the gas cavity of tank No 1 (No 2, No 3) into the cylinders 2, thereby "unloading" the tank sylphons. With the creation of supercharging in the containers for fuel aboard the "Progress" and after opening the valves 12 and 7 (8, 9) the fuel fills tank No 1 (No 2, No 3).

C. CE Operation

I. Pumping of fuel from tank No 2 into tank No 1. From the gas cavity of tank No 1 with the open valves 4 and 10 the compressor 11 forces the nitrogen into the cylinders 2. By the supercharging pressure in tank No 2 (the valves 1, 5, 8, 7, are opened, the reducer 3 operates) the fuel from tank No 2 is reforced into tank No 1.

II. Preparation of tank No 2 for reception of fuel from tank No 3. From the gas cavity of the tank No 2, with open valves 5 and 10, the compressor 11 forces the nitrogen into the cylinders 2.

III. Separation of liquid and gas phases in tank No 3. The "Soyuz-32"-"Salyut-6"-"Progress-5" complex is turned relative to the transverse axis. Under the influence of centrifugal force the liquid fuel in the tank No 3 is forced to the intake pipe and the gas bubbles "float" in a direction toward the center of rotation.

IV. Pumping of main part of separated fuel from tank No 3 into tank No 2. By the pressure of supercharging in tank No 3 (the valves 1, 6, 9, 8 are opened, the reducer 3 operates) the fuel is reforced from tank No 3 into tank No 2.

V. Pumping of fuel residue from tank No 3 into tanks of "Progress-5" ship. With the same supercharging pressure in tank No 3 (valves 1 and 6 are opened, the reducer 3 operates) and the opened valves 9 and 12 the fuel residue is pumped into the empty tanks of the "Progress-5" ship.

[annotations to block diagram continued]

VI. Drainage of supercharging system. With the opened valves 6 and 13 the vapor-gas mixture from the lines of the supercharging system and the freed tank No 3 is dumped into open space.

VII. Scavenging of lines by compressed nitrogen. With the opened valves 1, 6 and 13 and the operating reducer 3 the lines for supercharging tank No 3 and tank No 3 itself are scavenged by gaseous nitrogen.

Other annotations:

A. "Soyuz-32"
B. "Salyut-6"
C. "Progress-5"
D. Freight compartment
E. Instrument-assembly compartment
F. Compartment of refueling components
G. Surface charging with nitrogen
H. Into open space
I. Refueling control panel
J. Orientation and control of motion system
K. Tank
L. To the "Progress"
M. From oxidizer tanks
N. "Salyut-6"
O. Centrifugal forces
P. Into tank...to "Progress-5"
Q. To open space

However, the freeing of the nitrogen lines, or, as is customary to say, drainage into open space, is a problem which is not entirely solved. Ground tests have shown that metal subjected to prolonged exposure to asymmetric dimethylhydrazine does not immediately "give up" the adsorbed, that is, impregnated fuel, absorbed by the surface. Therefore, the pneumatic lines freed of fuel vapors were scavenged by compressed nitrogen and exposed to seven days of a space vacuum. On 23 March there was repeated scavenging of the lines and the damaged tank by compressed nitrogen. Finally, on 27 March, after the next scavenging and vacuuming, tank No 3 was filled with compressed nitrogen and by closing of the valves both along the nitrogen line and along the fuel line, was cut off from the fuel system. Further operation of the "Salyut-6" engine with satisfaction of the necessary dynamic operations is ensured by fuel from the two properly operating engines.

Thus, a great complex of technological measures was taken in circumterrestrial orbit. Much preventive maintenance work was done with one of the vitally important orbital station systems. This work demonstrated the broad possibilities of space technology, the correctness of the technical ideas incorporated in it, and the highly professional qualities of the people creating this apparatus and those working with it.
[469-5303]

Abstracts of Scientific Articles

DETERMINATION OF COORDINATES OF FEATURES FROM SCANNER PHOTOGRAPHS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 3, 1979, pp 88-92

[Article by O. I. Yegorova, Institute of Geodetic, Aerial Mapping and Cartographic Engineers, "Some Aspects of Determining Coordinates of Features from Scanner Photographs"]

[Abstract] The article describes an analytical method for determining the coordinates of features detectable on photographs obtained using optical-mechanical scanning systems with linear scanning in the IR range under the condition that the geometry of image construction is known. Definite operations are performed and these are described. 1. Measurement of coordinates of photograph points. 2. Transformation of coordinates of photograph points from the system of instrument coordinates to the system of photograph coordinates. 3. Reduction of coordinates of photograph points to a common origin at the center of the frame. 4. Transformation of the ordinates of the feature on a cylinder to the ordinate on a plane. 5. Computation of photogrammetric coordinates of feature. 6. Computation of space coordinates of images of features in a photogrammetric coordinate system. 7. Correction of coordinates of features for influence of atmospheric refraction and for the earth's curvature. 8. Transformation of geographic coordinates of carrier into Gaussian rectangular coordinates. 9. Computation of coordinates of feature in a system of Gaussian coordinates. The examined analytical method for determining the coordinates of features from IR scanner photographs can be used in solving problems for both topographic and special (geology, forestry and agriculture, ice reconnaissance, hydrology, etc.) purposes.
[478-5303]

RANGE OF INTERFEROMETERS IN TURBULENT ATMOSPHERE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 3, 1979 pp 97-100

[Article by A. S. Medovikov, Institute of Geodetic, Aerial Mapping and Cartographic Engineers, "Effective Range of Interferometers in a Turbulent Atmosphere"]

[Abstract] In operation of interferometers in the open atmosphere, which is always turbulent, the contrast of the interference pattern can be so low that the measurements will be impossible. In such cases the instrument registers the continuous background, not the interference pattern. This article gives formulas for the principal turbulent effects distorting the contrast of the interference pattern. The effects considered here include random frequency modulation associated with the Doppler effect in the scattering of radiation on moving inhomogeneities; phase fluctuations during the propagation of waves in the turbulent atmosphere; interference of light beams when one of them has passed through the turbulent atmosphere. A formula is given for the characteristic distance representing the maximum effective range of the interferometer when there are only amplitude fluctuations. The materials presented here indicate the possibility of interference measurements in the region of "weak fluctuations" and in the presence of a region of "strong fluctuations." This characteristic distance is determined for both phase and amplitude fluctuations. The findings can be used in designing interferometers operating in the open atmosphere.
[478-5303]

PHENOMENA ACCOMPANYING PENETRATION OF SOLAR COSMIC RADIATION INTO MAGNETOSPHERE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 247, No 4, 1979 pp 826-829

[Article by N. K. Pereyaslova and N. A. Mikirova, Institute of Applied Geophysics, "Influence of Processes of Penetration of Solar Cosmic Radiation Into the Earth's Magnetosphere on the Spectral Characteristics of Proton Fluxes"]

[Abstract] A study was made of the spectral characteristics of proton fluxes registered in the polar caps. In describing the integral spectra use was made of a power-law energy representation $N(E) = AE^{-\gamma}$. The spectral exponent γ was computed for two energy ranges 5-15 and 15-40 MeV. The values of the spectral components for over the polar caps were taken with an interval of 1 minute between the computed data. As a result of the existence of an anisotropic stage in the angular distribution of proton fluxes frequently in the polar cap regions there are nonuniformities of proton intensity. The following events were examined: 7-8 August 1972, 7 September 1973, 5-6 July 1974 and 12 September 1974. Table 1, for the mentioned events, characterized

by considerable nonuniformities in the distribution of proton fluxes over the polar caps, gives the spectral exponents in the different regions of the polar peaks, valleys, and the invariant latitudes at which the spectra of solar cosmic radiation were computed. It is shown that the spectra of solar cosmic radiation in the region of valleys at invariant latitudes Φ = 61-75° are harder than the spectra in the region of the polar peak at Φ = 77°. The observed difference in the spectral characteristics of solar cosmic radiation for the polar caps can be explained in the following way. The proton fluxes at the invariant latitudes greater than the invariant latitudes of the auroral peaks are caused by particles having great pitch angles, whereas in the regions of the polar peaks they are caused by the anisotropic part of the flux with small pitch angles. Accordingly, the difference in intensities in the regions of the polar peaks and valleys characterizes the anisotropy of the angular distribution of solar cosmic radiation and in the presence of a difference in the anisotropy of the angular distribution of the proton fluxes for different energy ranges the relationship between high- and low-energy fluxes of solar cosmic radiation will be dependent on the pitch angle. A parameter is proposed for characterizing the degree of anisotropy of the angular distribution of solar cosmic radiation. This investigation of the spatial distributions of the spectral exponents for solar cosmic radiation for the polar cap made it possible in the stage of anisotropy of the angular distributions of protons for the first time to discover the following peculiarities: a distinct north-south asymmetry of the spectral exponents of solar cosmic radiation in the deep polar cap; a difference in the spectral exponents of proton fluxes registered in the regions of the polar peaks, cusps and valleys.
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